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Working Paper

REMOTELY PILOTED VEHICLE (AQUILA) FORCE DEVELOPMENT TEST AND EXPERIMENTATION (FDTE): ARMY RESEARCH INSTITUTE FORT HOOD FIELD UNIT EVALUATION (1987)

Nigel R. Nicholson
Gerard M. Deignan
Edwin R. Smootz

Fort Hood Field Unit

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U.S. Army Research Institute
for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria VA 22333

INTRODUCTION

This Working Paper represents the Fort Hood Army Research Institute (ARI) Field Unit contribution to the TRADOC Test and Experimentation Command (TEXCOM) (Provisional) report of the 1987 Remotely Piloted Vehicle (RPV) (Aquila) Force Development Test and Experimentation (FDTE). This report was submitted to TEXCOM on 12 January 1988.

The report is presented in four sections. Section I presents a summary of conflict resolution information gathered from an analysis of video tapes. These analyses are in response to Evaluation Plan Criteria 2.2.1.2.2 ("The GCS crew must identify incomplete mission order request forms and high risk or nonexecutable missions, and resolve conflicts.") Section II presents the results of questionnaires administered after each RPV flight to assess the impact of a fourth crewmember of GCS operations. Section III also addresses the impact of a fourth crewmember on GCS operations but presents data from questionnaires administered at the end of the test. Section IV is a narrative summary of the results.

The purpose of this report was to provide TEXCOM with data that could be integrated with data from other sources in producing a final report. The organization and format of this report reflect that purpose.

I. GCS Crew-TOC Conflict Resolution

Figures 1 through 4 address Evaluation Plan criterion 2.2.1.2.2, "The GCS crew must identify incomplete mission order request forms and high risk or nonexecutable missions, and resolve conflicts". The videotapes made of a) the MC receiving an RPV mission at TOC, b) crews planning a mission, and c) crews flying a mission, were scored as to the number of times that a GCS crew questioned the TOC as to the feasibility of the mission given to the RPV, and the number of times that the crew explained RPV capabilities to the TOC. On the 20 flights (4 crews executing 5 missions) that were scored, there were a total of 79 such communications. As can be seen in Figure 1, 29 of these occurred during mission briefing at TOC, 25 occurred during mission planning, and 25 occurred during flight. Thus, conflict resolution was fairly evenly spread out over the three phases of mission execution, although 68% of the conflict resolution that occurred did take place prior to mission flight.

Figures 2 through 4 show the proportion of total communications that were devoted to conflict resolution during each of the mission execution phases. As can be seen in Figure 2, conflict resolution is the predominant communications activity during mission briefing at the TOC, making up 88% of the MC-TOC communications in that phase. During mission planning (Figure 3) the total number of conflict resolution communications stays about the same as during mission briefing, although the proportion of conflict resolution events relative to the total number of communications during mission planning falls to about eight percent. Finally, during flight (Figure 4) the absolute number of

conflict resolution events remains about the same as in the previous phases, although as a proportion of the total communications in mission flight it falls to less than 1%.

In summary, then, it appears that crews did engage in conflict resolution during the execution of RPV missions with about two-thirds of such activity occurring prior to mission flight and one-third occurring during mission flight.

Figure 1: Deconflicting Behavior

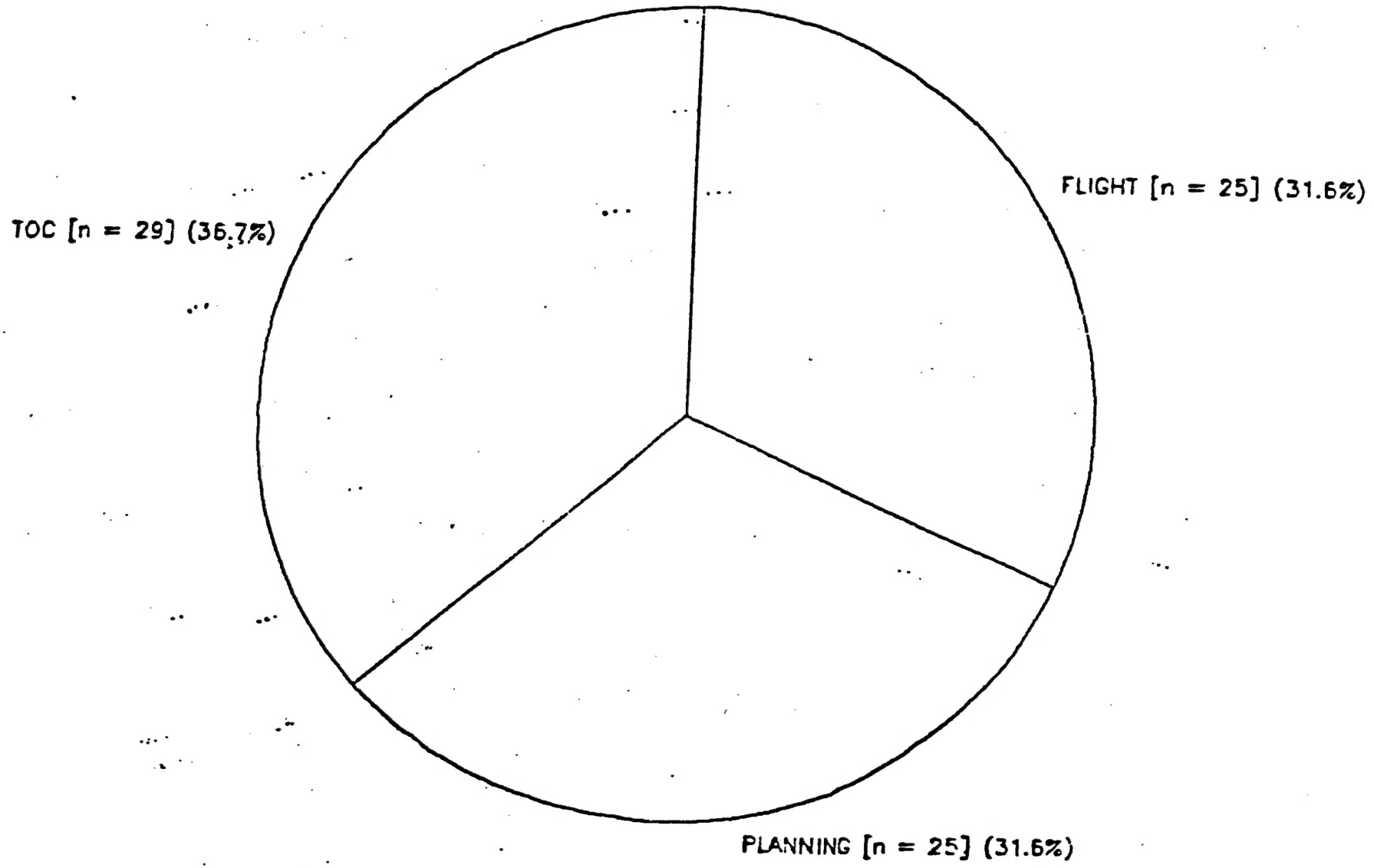


Figure 2: TOC Communications

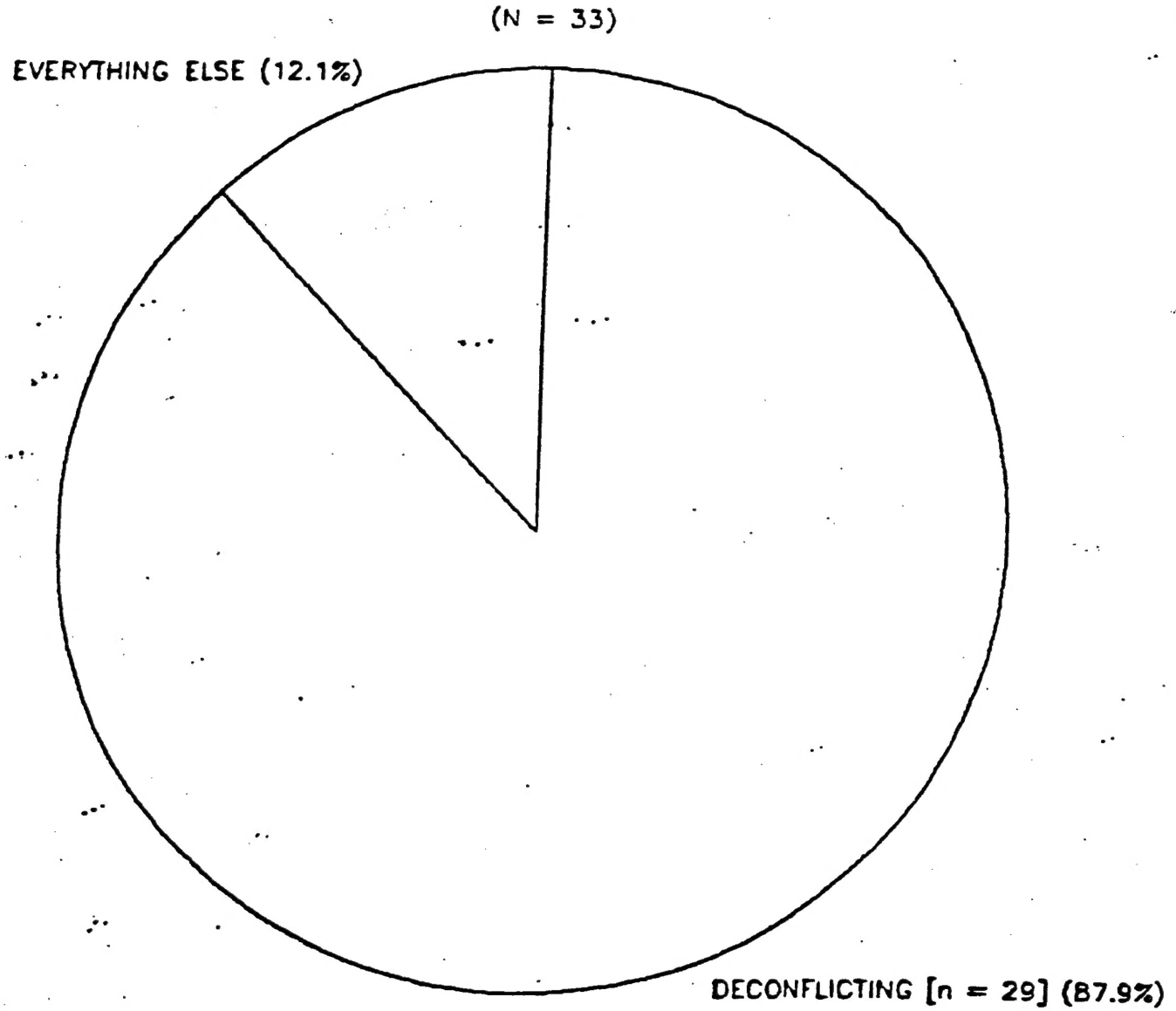


Figure 3: Planning Communications

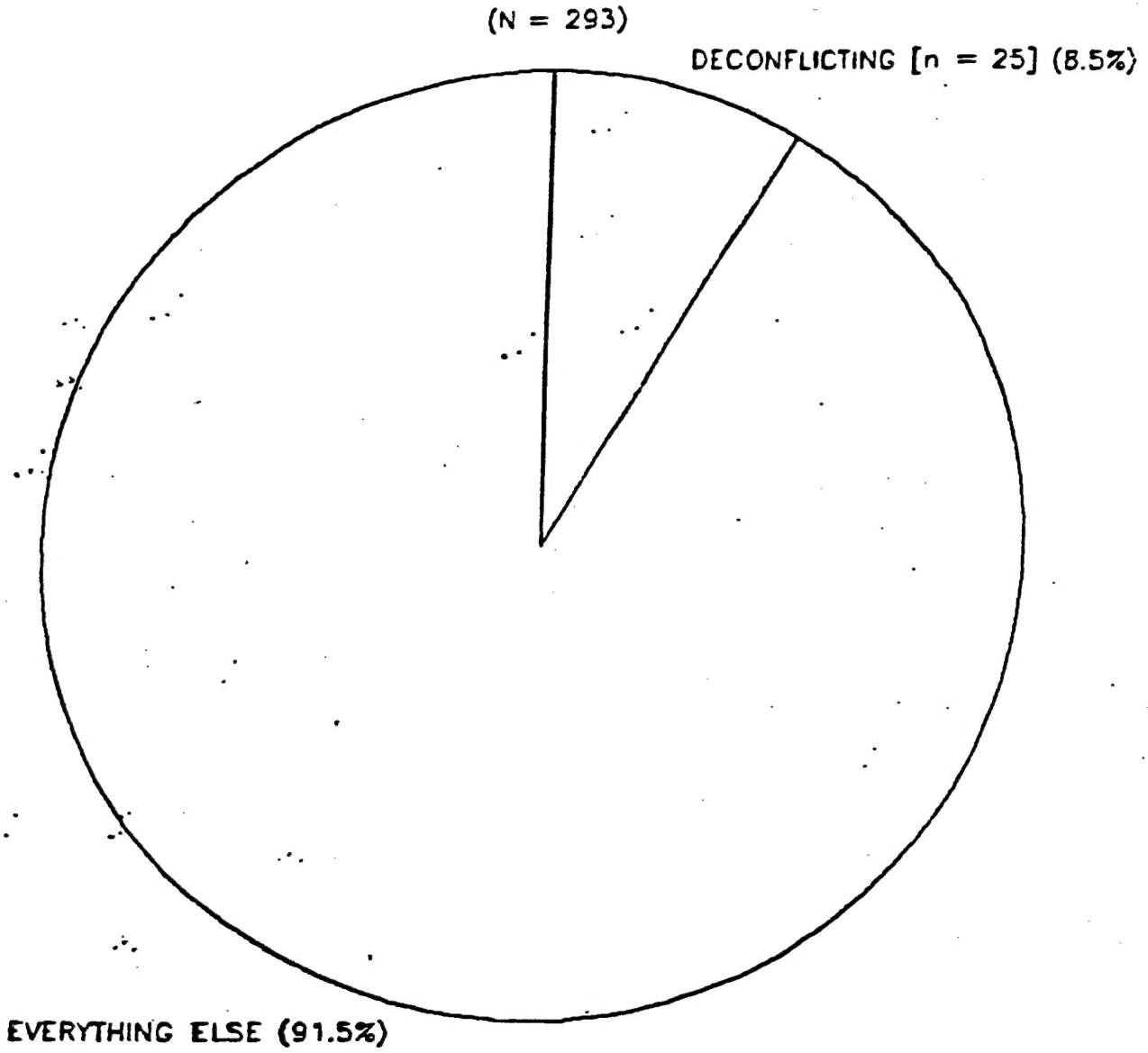
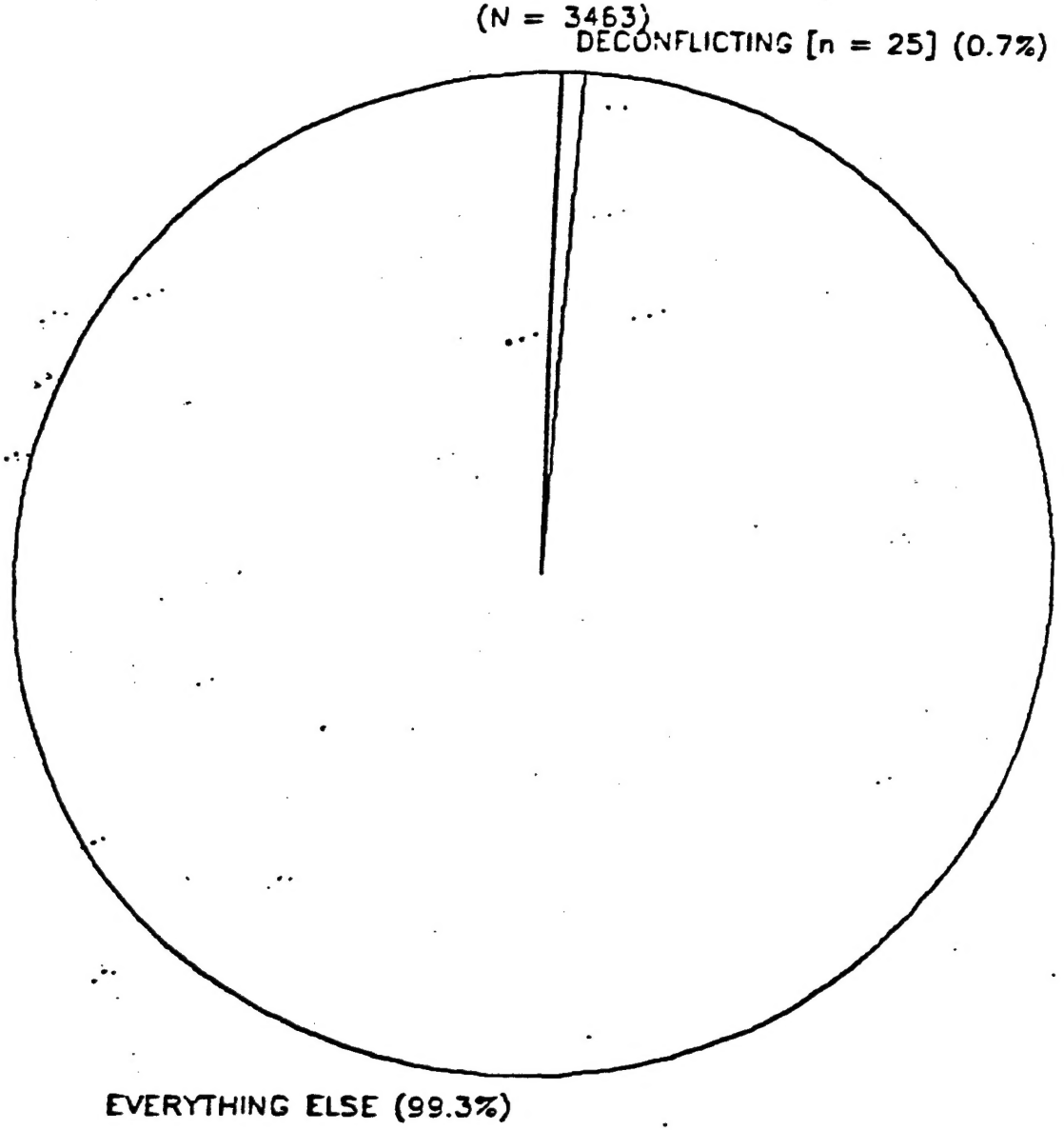


Figure 4: Flight Communicotions



II: Post-flight Questionnaires

At the end of each flight the four crewmen attended an ARI debriefing and completed the questionnaire found in Appendix A. In all, 92 post-flight questionnaires were completed. The respondents were instructed to complete the questionnaire as it pertained to their latest flight.

Descriptive statistics are shown below, with brief item explanations. (The exact wording of each item is presented in Appendix A.) The data are given for (1) all crew members, then for (2) each position, then for (3) each crew.

ALL CREW MEMBERS

Item 1: Did you look for targets?
No = 1 Yes = 91

Item 2: Who reported the first target detection?
MC = 12 Tech = 23 AVO = 16 MPO = 39 No response = 2

Item 3: Who reported most target detections?
MC = 4 Tech = 9 AVO = 13 MPO = 51 No response = 15

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.7 SD = 0.9
Tech Mean = 3.3 SD = 0.9
AVO Mean = 2.5 SD = 0.8
MPO Mean = 1.3 SD = 0.7

Item 5: Who was unnecessary for target detection?
MC = 15 Tech = 34 AVO = 0 MPO = 0 No one = 43

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 0.9
Tech Mean = 3.3 SD = 0.9
AVO Mean = 2.7 SD = 0.9
MPO Mean = 1.6 SD = 1.0

Item 7: Who was unnecessary for target recognition?
MC = 10 Tech = 39 AVO = 3 MPO = 0 No one = 40

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 1.1
Tech Mean = 2.9 SD = 1.1
AVO Mean = 2.2 SD = 1.0
MPO Mean = 2.4 SD = 1.0

Item 9: Who was unnecessary for overall mission success?
MC = 12 Tech = 27 AVO = 0 MPO = 0 No one = 53

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.4 SD = 2.0
Latest Mission Mean = 4.2 SD = 2.4

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.6 SD = 1.8

MISSION COMMANDERS

Item 1: Did you look for targets?
No = 0 Yes = 23

Item 2: Who reported the first target detection?
MC = 5 Tech = 6 AVO = 6 MPO = 6 No response = 0

Item 3: Who reported most target detections?
MC = 3 Tech = 2 AVO = 4 MPO = 14 No response = 0

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.7 SD = 1.0
Tech Mean = 3.2 SD = 0.9
AVO Mean = 2.3 SD = 0.9
MPO Mean = 1.7 SD = 1.0

Item 5: Who was unnecessary for target detection?
MC = 0 Tech = 3 AVO = 0 MPO = 0 No one = 20

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 1.6 SD = 0.5
Tech Mean = 3.1 SD = 0.9
AVO Mean = 2.9 SD = 0.9
MPO Mean = 2.3 SD = 1.3

Item 7: Who was unnecessary for target recognition?
MC = 0 Tech = 5 AVO = 3 MPO = 0 No one = 15

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.6 SD = 1.2
Tech Mean = 2.8 SD = 0.9
AVO Mean = 2.3 SD = 1.1
MPO Mean = 2.4 SD = 1.0

Item 9: Who was unnecessary for overall mission success?
MC = 0 Tech = 0 AVO = 0 MPO = 0 No one = 23

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.6 SD = 1.6
Latest Mission Mean = 4.5 SD = 2.3

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.1 SD = 1.7

TECHNICIANS

Item 1: Did you look for targets?
No = 0 Yes = 23

Item 2: Who reported the first target detection?
MC = 3 Tech = 4 AVO = 1 MPO = 14 No response = 1

Item 3: Who reported most target detections?
MC = 0 Tech = 3 AVO = 2 MPO = 9 No response = 9

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 0.6
Tech Mean = 3.9 SD = 0.5
AVO Mean = 2.4 SD = 0.7
MPO Mean = 1.1 SD = 0.5

Item 5: Who was unnecessary for target detection?
MC = 0 Tech = 15 AVO = 0 MPO = 0 No one = 8

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.5 SD = 0.6
Tech Mean = 3.8 SD = 0.6
AVO Mean = 2.5 SD = 0.7
MPO Mean = 1.0 SD = 0.2

Item 7: Who was unnecessary for target recognition?
MC = 1 Tech = 14 AVO = 0 MPO = 0 No one = 8

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.1 SD = 1.0
Tech Mean = 3.2 SD = 1.0
AVO Mean = 2.2 SD = 0.9
MPO Mean = 2.4 SD = 1.2

Item 9: Who was unnecessary for overall mission success?
MC = 1 Tech = 12 AVO = 0 MPO = 0 No one = 10

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 6.8 SD = 2.2
Latest Mission Mean = 4.5 SD = 2.4

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 3.5 SD = 2.2

AIR VEHICLE OPERATOR

Item 1: Did you look for targets?
No = 1 Yes = 22

Item 2: Who reported the first target detection?
MC = 2 Tech = 7 AVO = 4 MPO = 9 No response = 1

Item 3: Who reported most target detections?
MC = 0 Tech = 3 AVO = 4 MPO = 13 No response = 3

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 3.0 SD = 0.9
Tech Mean = 3.0 SD = 1.1
AVO Mean = 2.7 SD = 0.9
MPO Mean = 1.3 SD = 0.6

Item 5: Who was unnecessary for target detection?
MC = 9 Tech = 8 AVO = 0 MPO = 0 No one = 6

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.7 SD = 1.0
Tech Mean = 3.1 SD = 1.0
AVO Mean = 2.6 SD = 0.8
MPO Mean = 1.5 SD = 0.8

Item 7: Who was unnecessary for target recognition?
MC = 4 Tech = 11 AVO = 0 MPO = 0 No one = 8

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.7 SD = 1.1
Tech Mean = 2.8 SD = 1.3
AVO Mean = 2.3 SD = 1.2
MPO Mean = 2.2 SD = 0.7

Item 9: Who was unnecessary for overall mission success?
MC = 6 Tech = 8 AVO = 0 MPO = 0 No one = 9

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.3 SD = 2.2
Latest Mission Mean = 3.0 SD = 2.3

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.8 SD = 1.5

MISSION PAYLOAD OPERATOR

Item 1: Did you look for targets?
No = 0 Yes = 23

Item 2: Who reported the first target detection?
MC = 2 Tech = 6 AVO = 5 MPO = 10 No response = 0

Item 3: Who reported most target detections?
MC = 1 Tech = 1 AVO = 3 MPO = 15 No response = 3

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.9 SD = 0.8
Tech Mean = 3.3 SD = 0.9
AVO Mean = 2.6 SD = 0.8
MPO Mean = 1.2 SD = 0.5

Item 5: Who was unnecessary for target detection?
MC = 6 Tech = 8 AVO = 0 MPO = 0 No one = 9

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.5 SD = 1.0
Tech Mean = 3.2 SD = 0.9
AVO Mean = 2.8 SD = 1.0
MPO Mean = 1.6 SD = 1.0

Item 7: Who was unnecessary for target recognition?
MC = 5 Tech = 9 AVO = 0 MPO = 0 No one = 9

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.3 SD = 1.2
Tech Mean = 3.0 SD = 1.3
AVO Mean = 2.1 SD = 0.9
MPO Mean = 2.6 SD = 1.0

Item 9: Who was unnecessary for overall mission success?
MC = 5 Tech = 7 AVO = 0 MPO = 0 No one = 11

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.8 SD = 1.9
Latest Mission Mean = 4.9 SD = 2.1

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.1 SD = 1.7

CREW A

Item 1: Did you look for targets?
No = 0 Yes = 24

Item 2: Who reported the first target detection?
MC = 1 Tech = 4 AVO = 8 MPO = 11 No response = 0

Item 3: Who reported most target detections?
MC = 1 Tech = 1 AVO = 10 MPO = 9 No response = 3

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.7 SD = 0.9
Tech Mean = 3.6 SD = 0.9
AVO Mean = 2.0 SD = 0.8
MPO Mean = 1.8 SD = 1.0

Item 5: Who was unnecessary for target detection?
MC = 4 Tech = 13 AVO = 0 MPO = 0 No one = 7

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.2 SD = 1.0
Tech Mean = 3.2 SD = 1.0
AVO Mean = 2.3 SD = 0.8
MPO Mean = 2.4 SD = 1.3

Item 7: Who was unnecessary for target recognition?
MC = 3 Tech = 13 AVO = 0 MPO = 0 No one = 8

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 2.0 SD = 0.9
Tech Mean = 3.5 SD = 0.8
AVO Mean = 1.7 SD = 0.8
MPO Mean = 2.7 SD = 1.0

Item 9: Who was unnecessary for overall mission success?
MC = 1 Tech = 9 AVO = 0 MPO = 0 No one = 14

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 6.2 SD = 2.4
Latest Mission Mean = 2.9 SD = 1.8

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.6 SD = 2.1

CREW B

Item 1: Did you look for targets?
No = 1 Yes = 23

Item 2: Who reported the first target detection?
MC = 9 Tech = 4 AVO = 0 MPO = 9 No response = 2

Item 3: Who reported most target detections?
MC = 3 Tech = 0 AVO = 1 MPO = 9 No response = 11

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.0 SD = 0.0
Tech Mean = 3.4 SD = 0.6
AVO Mean = 3.4 SD = 0.6
MPO Mean = 1.0 SD = 0.2

Item 5: Who was unnecessary for target detection?
MC = 0 Tech = 7 AVO = 0 MPO = 0 No one = 17

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.0 SD = 0.0
Tech Mean = 3.4 SD = 0.6
AVO Mean = 3.4 SD = 0.6
MPO Mean = 1.0 SD = 0.2

Item 7: Who was unnecessary for target recognition?
MC = 0 Tech = 8 AVO = 0 MPO = 0 No one = 16

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 1.4 SD = 0.7
Tech Mean = 2.6 SD = 1.1
AVO Mean = 3.0 SD = 0.7
MPO Mean = 3.0 SD = 0.9

Item 9: Who was unnecessary for overall mission success?
MC = 0 Tech = 4 AVO = 0 MPO = 0 No one = 20

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 7.7 SD = 2.7
Latest Mission Mean = 4.5 SD = 0.9

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 1.6 SD = 0.9

CREW C

Item 1: Did you look for targets?
No = 0 Yes = 20

Item 2: Who reported the first target detection?
MC = 0 Tech = 7 AVO = 6 MPO = 7 No response = 0

Item 3: Who reported most target detections?
MC = 0 Tech = 6 AVO = 2 MPO = 12 No response = 0

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 2.9 SD = 0.9
Tech Mean = 2.9 SD = 1.2
AVO Mean = 2.8 SD = 0.6
MPO Mean = 1.3 SD = 0.7

Item 5: Who was unnecessary for target detection?
MC = 8 Tech = 2 AVO = 0 MPO = 0 No one = 10

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 1.3
Tech Mean = 2.8 SD = 1.2
AVO Mean = 2.8 SD = 0.7
MPO Mean = 1.8 SD = 0.8

Item 7: Who was unnecessary for target recognition?
MC = 6 Tech = 5 AVO = 3 MPO = 0 No one = 6

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 3.1 SD = 1.4
Tech Mean = 1.5 SD = 0.6
AVO Mean = 3.1 SD = 0.6
MPO Mean = 2.3 SD = 0.7

Item 9: Who was unnecessary for overall mission success?
MC = 10 Tech = 0 AVO = 0 MPO = 0 No one = 10

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 9.1 SD = 1.2
Latest Mission Mean = 3.7 SD = 2.5

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 2.9 SD = 1.8

CREW D

Item 1: Did you look for targets?
No = 0 Yes = 24

Item 2: Who reported the first target detection?
MC = 2 Tech = 8 AVO = 2 MPO = 12 No response = 0

Item 3: Who reported most target detections?
MC = 0 Tech = 2 AVO = 0 MPO = 21 No response = 1

Item 4: Rank order importance of each crewman for target detection.
(1.0 most important; 4.0 least important)
MC Mean = 3.3 SD = 0.6
Tech Mean = 3.4 SD = 0.8
AVO Mean = 2.1 SD = 0.5
MPO Mean = 1.0 SD = 0.2

Item 5: Who was unnecessary for target detection?
MC = 3 Tech = 12 AVO = 0 MPO = 0 No one = 9

Item 6: Rank order importance of each crewman for target recognition.
(1.0 most important; 4.0 least important)
MC Mean = 2.4 SD = 1.3
Tech Mean = 2.8 SD = 1.2
AVO Mean = 2.8 SD = 0.7
MPO Mean = 1.8 SD = 0.8

Item 7: Who was unnecessary for target recognition?
MC = 1 Tech = 13 AVO = 0 MPO = 0 No one = 10

Item 8: Rank order importance of each crewman for overall mission success.
(1.0 most important; 4.0 least important)
MC Mean = 3.3 SD = 0.5
Tech Mean = 3.6 SD = 0.6
AVO Mean = 1.5 SD = 0.5
MPO Mean = 1.7 SD = 0.8

Item 9: Who was unnecessary for overall mission success?
MC = 1 Tech = 14 AVO = 0 MPO = 0 No one = 9

Item 10: Compare workload of normal flights with latest flight.
(1.0 not busy at all; 10.0 very busy)
Normal Mission Mean = 6.9 SD = 1.3
Latest Mission Mean = 5.8 SD = 1.7

Item 11: Perform own tasks / Perform other crew members' tasks.
(1.0 = Totally own tasks; 10.0 = Totally others tasks)
Mean = 3.2 SD = 1.9

III: Post-Test Questionnaire

At the end of the test all crewmen attended an ARI debriefing and completed the questionnaire found in Appendix B. In all, 17 post-test questionnaires were completed. The respondents were instructed to complete the questionnaire as it pertained to their overall experience of the GCS.

Descriptive statistics are shown below, with brief item explanations. (The exact wording of each item is presented in Appendix B.) The data for items one through nine are given for (1) all crew members together, on pages 11 & 12; then for (2) each position, on pages 13-15; then for (3) each crew, on pages 15-17. The responses to items 10 & 11 are summarized on pages 18-21.

ALL CREW MEMBERS

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 5.4 SD = 2.5

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 3.9 SD = 2.1

Item 3: Equipment which obstructs.
(Equipment which two or more respondents listed as obstructions.)

Radio rack	13
Teleprinter	6
Chairs	4
Chemical warning box	4
Headset cables	3
NDU plotting arm	3
People	3
Cover on lights	2
Cabinet over plotting table	2

Item 4: Effect of equipment obstructions.
(Comments made by two or more respondents.)

Interferes with movement in GCS	9
Slows mission performance	4
Headset cables obscure console displays and controls	2

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 3.7 SD = 2.1

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 4.3 SD = 3.4

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 7.2 SD = 2.6

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 6.9 SD = 2.2

Item 8: Respondent Comments. Nine comments indicated that having a fourth crewman was helpful in handling communications. Three comments indicated that record keeping was helped. Two comments indicated that it helped in GMD operations.

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 6.2 SD = 2.5

Item 10: See pages 18 & 19.

Item 11: See pages 20 & 21.

Item 12: No usable data were obtained.

Item 13: No usable data were obtained.

MISSION COMMANDER

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 5.0 SD = 2.7

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 2.5 SD = 1.0

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 4.0 SD = 1.4

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = N/A SD = N/A

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 7.5 SD = 2.4

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 7.8 SD = 1.0

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 5.0 SD = 2.7

TECHNICIAN

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 6.8 SD = 2.9

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 5.0 SD = 2.8

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 3.0 SD = 2.4

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 4.3 SD = 3.4

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 8.3 SD = 1.5

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 7.8 SD = 2.1

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 6.3 SD = 3.0

AIR VEHICLE OPERATOR

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 3.8 SD = 1.7

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 3.0 SD = 0.8

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 5.8 SD = 2.2

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = N/A SD = N/A

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 5.5 SD = 3.5

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 4.8 SD = 2.6

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 5.3 SD = 2.2

MISSION PAYLOAD OPERATOR

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 5.8 SD = 2.6

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 5.0 SD = 2.0

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 2.4 SD = 1.1

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = N/A SD = N/A

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 7.4 SD = 2.8

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 7.2 SD = 1.8

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 8.0 SD = 1.7

CREW A

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 6.0 SD = 2.9

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 3.8 SD = 2.2

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 3.4 SD = 3.0

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 3.0 SD = 0.0

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 7.4 SD = 3.2

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 5.8 SD = 0.8

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 6.6 SD = 2.9

CREW B

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 6.8 SD = 2.9

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 5.0 SD = 2.7

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 2.5 SD = 1.3

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 1.0 SD = 0.0

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 8.3 SD = 1.7

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 9.0 SD = 1.4

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 6.5 SD = 2.6

CREW C

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 3.8 SD = 1.5

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 3.3 SD = 1.3

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 5.0 SD = 1.8

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 4.0 SD = 0.0

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 7.8 SD = 1.9

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 6.0 SD = 3.4

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 5.5 SD = 3.1

CREW D

Item 1: Frequency of equipment obstruction in GCS.
(1.0 = Never; 10.0 = All the time)
Mean = 4.8 SD = 2.2

Item 2: Severity of equipment obstruction.
(1.0 = None; 10.0 = Very much)
Mean = 3.8 SD = 2.2

Item 5: Crowdedness of GCS.
(1.0 = crowded; 10.0 = spacious)
Mean = 4.0 SD = 1.4

Item 6: Technician only: Fatigue due to lack of seat.
(1.0 = very fatigued; 10.0 = no fatigue)
Mean = 9.0 SD = 0.0

Item 7: Commo net congestion due to fourth man.
(1.0 = very much; 10.0 = none)
Mean = 5.3 SD = 3.0

Item 8: Effect of fourth man on mission performance.
(1.0 = lowers a lot; 10.0 = helps a lot)
Mean = 7.0 SD = 1.2

Item 9: Overlap of Mission commander and Technician duties.
(1.0 = none; 10.0 = very much)
Mean = 6.3 SD = 2.2

The following pages summarize the responses to items 10 and 11, in which the crewmen listed their duties during: (1) mission planning and (2) mission flight. Items for which the duties of the MC and the TC overlap are displayed in **bold** type for emphasis.

Reference: Duties listed in Item 10 (Mission Planning)

1. Supervise mission planning process
2. Receive mission order from TOC
3. Deconflict mission order with TOC
4. Brief crew on mission order (including enemy situation, etc.)
5. Prepare situation overlay
6. Evaluate weather conditions / Gather weather data
7. Perform map reconnaissance
8. Plan waypoints
9. Prepare mission planning worksheet
10. Prepare target/search file worksheet
11. Enter mission plan and other data
12. Verify mission plan
13. Plot plan on VDU
14. Coordinate AV handoff
15. Advise MC on probability of mission accomplishment
16. Outline how to fly mission

Table 1. Crew responses to Item 10

Item	MC	TC	AVO	MPO
1	BD	CD	C	
2	ABCD	C		
3	ABCD	BC	D	
4	ABCD	BC		
5	BD	AC	D	ABD
6	AC	BC	BD	AB
7	ABCD	C	D	
8	AB	BC	D	BCD
9	AB	BC	D	
10	AB	BC	D	
11			ABD	CD
12	ABC	BC	AB	A
13		B	B	ABCD
14	B		AD	
15		BD		
16	C			

Table 1 displays crew reports of their Aquila duties during mission planning. For example, for item 1 "Supervise mission planning process", MC's from crews B&D, TC's from crews C&D and the AVO from crew C, all reported that this was part of their Aquila duties during mission planning.

Reference: Duties listed in Item 11 (Mission Flight)

1. Activate and check system
2. Supervise overall mission
3. Operate AVO console
4. Operate MPO console
5. Operate MC console
6. Search for targets and DRL
7. Maintain flight/duty log
8. Coordinate GCS crew activities
9. Coordinate RPV section activities
10. Maintain communications with TOC
11. Lead post-flight debriefing
12. Shut down system
13. Set up / monitor MIM
14. Communicate with flight operations
15. Operate air conditioners
16. Monitor power supply
17. Ensure tactical doctrine and commander's intent
18. Monitor AV status at VDU
19. Advise MC
20. Plot direct targets
21. Launch, handoff, and recover AV

Table 2. Crew responses to Item 11

Item	MC	TC	AVO	MPO
1			BD	ACD
2	ABC	CD		
3		BC	ABD	
4			D	ACD
5	ABD	D	D	
6	ABC	ABCD	BD	ABCD
7		ABD	D	
8	ABC	CD		
9	B	D	D	
10	ABCD	ABD	ABD	ABD
11	AB			
12			BD	ACD
13		B	A	C
14			A	
15				A
16				A
17	B			
18		B		
19		B		
20		B		
21		C	BCD	

Table 2 displays crew reports of their Aquila duties during mission flight. For example, for item 1 "Activate and check out systems", AVO's from crews B&D, and MPO's from crews A,C&D reported that this was part of their Aquila duties during mission flights.

IV: Summary

A: Primary results from the post-flight questionnaire, which was administered at the end of each flight, are as follows:

ALL CREW MEMBERS COMBINED

(1) As expected, although all crewmen reported looking for targets, the crews reported that the mission payload operator (MPO) detected the most targets and was usually the first to detect a target.

(2) The GCS crews rated the MPO the most important crewman for target detection and recognition.

(3) No crew members considered the MPO unnecessary for target detection, target recognition, or overall mission success.

(4) Essentially, no crew members considered the air vehicle operator (AVO) unnecessary for target detection or mission success.

(5) 16%, 11% and 13% of the crew responses rated the mission commander unnecessary for target detection, target recognition and mission success, respectively.

(6) 37%, 42% and 29% of the crew responses rated the technician unnecessary for target detection, target recognition and mission success, respectively.
target detection, recognition, or mission success.

(7) The crew members reported that their workload during FDT&E flights was lighter than during regular flights.

(8) The crewmen reported that they usually performed their own tasks during a mission. However, there was no consistent pattern across crews concerning the allocation of tasks during flights. In particular, the MC and TC tasks varied greatly between crews. (See post-test questionnaire results on pp 19 & 20.)

MISSION COMMANDERS

(1) The MC's rated the TC unnecessary for mission success on 50% of the missions.

(2) The MC's rated themselves unnecessary for mission success on only 5% of the missions.

TECHNICIANS

(1) The TC's rated themselves unnecessary for target detection on 64% of the missions.

(2) The TC's rated themselves unnecessary for target recognition on 45% of the missions.

(3) The TC's indicated that only on 10% of the missions had they or the MC's been unnecessary for mission success.

AIR VEHICLE OPERATORS and MISSION PAYLOAD OPERATORS

(1) The AVO's and MPO's indicated that the MC was unnecessary for mission success on 25% of the missions.

(2) The AVO's and MPO's indicated that the TC was unnecessary for mission success on 36% of the missions.

CREW DIFFERENCES

Three crews (A,B, & D) seldom, or never, found the MC unnecessary for mission success. However, 50% of the post-flight debriefs for crew C found the MC unnecessary for mission success.

In crews A & D (in which NCO's served as technicians) over 40% of the debriefs found the TC unnecessary for mission success. For crews B & C (in which warrant officers served as technicians) only 18% of crew B post-flight debriefs, and 0% of crew C post-flight debriefs, found the TC unnecessary for mission success.

RESEARCHER COMMENTS

(1) Researcher observations seem to indicate that, over all four crews, the degree of leadership displayed by the MC was inversely related to that of the TC.

(2) The crews' workload during the test flights was not as high as that expected in more realistic scenarios. There were several reasons for this, of course. One reason was the AVO's lack of duties during the flights. In any case, one must be cautious in generalizing results from the FDTE to Aquila operations in more realistic situations.

B: The post-test questionnaire (Appendix B) and debriefing interviews provided the basis for the following observations.

(1) The GCS with a four man crew is reported to be somewhat crowded.

(2) The TC is subjected to unnecessary fatigue due to the lack of seating.

(3) When asked to list their duties, during mission planning and mission flight, there is considerable variation across and among crews concerning how they perceive their tasks to be allocated. The most notable observation, perhaps, is that the NCO's who served as technicians (crews A & D) reported having few tasks during mission planning (Table 1, p 19), while warrant officers (crews B & C) who served as technicians reported having many of the same tasks as the MC's. This finding was not so salient for the mission flights (Table 2 p 21).

Researcher comments

All GCS crewmen should be provided adequate seating. The present arrangements made for the TC's are inadequate.

Attention needs to be given to differentiating MC and TC duties, especially in the light of the MC's greater tactical knowledge, the TC's greater technical knowledge, and the expectation for the Aquila RPV battery to operate 24 hours per day.

APPENDIX A: Post-Flight Questionnaire

We are investigating the effect of crew size on the success of the mission. Your responses will influence decisions that will be made concerning the organization of the GCS crews when this system is fielded. It is, therefore, important that you respond thoughtfully and forthrightly. Your responses will be held confidential, and will not be attributed to you as an individual. Answer the following items as they pertain ONLY to the mission you have most recently completed.

GCS crew _____ Flight number _____ Date ____/____/____

Position: MC__ Tech__ AVO__ MPO__ SSN (last four) |__|__|__|__|

(1).	Did you look for targets during the flight?	Yes _____ No _____
(2).	Which crew member reported the first target detection?	MC__ Tech__ AVO__ MPO__
(3).	Which crew member(s) reported most target detections?	MC__ Tech__ AVO__ MPO__
(4).	Using a 1 for most important, a 2 for second and so on, rank the importance of each crew member for <u>target detection</u>.	MC__ Tech__ AVO__ MPO__
(5).	Check any crew members who were unnecessary for <u>target detection</u>.	MC__ Tech__ AVO__ MPO__
(6).	Using a 1 for most important, a 2 for second and so on, rank the importance of each crew member for <u>target recognition</u>.	MC__ Tech__ AVO__ MPO__
(7).	Check any crew members who were unnecessary for <u>target recognition</u>.	MC__ Tech__ AVO__ MPO__
(8).	Using a 1 for most important, a 2 for second and so on, rank the importance of each crew member to the <u>overall success of the mission</u>.	MC__ Tech__ AVO__ MPO__
(9).	Check any crew members who were unnecessary to the <u>overall success of the mission</u>?	MC__ Tech__ AVO__ MPO__

(10). Compare how busy you would be during a normal mission (i.e., when the RPV battery flies a mission) to how busy you were during your last mission (i.e., when only the GCS crew were involved).

A. NORMAL MISSION 1...2...3...4...5...6...7...8...9...10
not busy at all very busy

B. LAST MISSION 1...2...3...4...5...6...7...8...9...10
not busy at all very busy

Comment below on any differences between your answers to A and B.

_____

_____

_____

(11). Indicate the extent to which you worked on your tasks and on other crew members tasks. 1...2...3...4...5...6...7...8...9...10
totally on my tasks totally on others tasks

List the tasks you were assigned on the last mission.

_____

_____

_____

List the tasks you performed on the last mission.

_____

_____

_____

APPENDIX B: Post-Test Questionnaire

GCS crew _____ Date ____/____/____

Position: MC__ Tech__ AVO__ MPO__ SSN (last four) |___|___|___|___|

[1] ALL: How often does the equipment physically get in your way?
1...2...3...4...5...6...7...8...9...10
never ... all the time

[2] ALL: How severely does this physical interference lower mission performance?
1...2...3...4...5...6...7...8...9...10
not at all ... very much

[3] ALL: List the specific equipment which gets in your way.

_____

_____

_____

[4] ALL: Explain how equipment interference lowers mission performance.

_____

_____

_____

[5] ALL: How crowded are the GCS working conditions?
1...2...3...4...5...6...7...8...9...10
crowded ... spacious

[6] TECH ONLY: How fatigued are you by the lack of seating?
1...2...3...4...5...6...7...8...9...10
very fatigued ... not at all

[7] ALL: To what extent does the fourth man increase commo net congestion?
1...2...3...4...5...6...7...8...9...10
very much ... not at all

[8a] ALL: How has adding a fourth crew member affected mission performance?

1...2...3...4...5...6...7...8...9...10
lowers a lot — no effect — helps a lot

[8b] ALL: If it helps, on what tasks does it help?

[9] ALL: To what degree do the duties of the MC and the technician overlap?

1...2...3...4...5...6...7...8...9...10
not at all — very much

[10] ALL: Describe in full your duties in planning a mission (use attached list as a general reference).

[11] ALL: Describe in full your duties in flying a mission (use attached list as a general reference).

[12] ALL: What duties, if any, overlap with those of another crew member? In what ways do they overlap? If the overlap is an unnecessary duplication of effort, whom do you think should have primary resposibility for that duty? Why?

[13] ALL: Are there duties that are performed at one position that really should be performed at another position? If so, explain what they are and who should perform each one.